TR-160

TECHNICAL REPORT

MARINE MAGNETIC SURVEY OFF THE SOUTHERN BAHAMAS PROJECT M-15

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ABSTRACT

A detailed geomagnetic and bathymetric survey of an 18,000-square-mile area off the southern Bahama Islands has revealed three distinctive magnetic lineations. These extensive magnetic features may indicate that the area is the focus of three major faults or fault zones.

FOREWORD

An important aspect of any oceanographic study is the delineation and interpretation of structural features in the earth's crust. To investigate these features in large oceanic areas masked by water and sediments, geophysical techniques must be employed. This report of a geomagnetic and bathymetric survey near the southern Bahama Islands helps to clarify the major crustal trends in this structurally complex area.

DENYS W. KNOLL
Rear Admiral, U. S. Navy
Commander

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FIGURES

I. INTRODUCTION

A survey of an area northeast of the southern Bahama Islands was conducted by USS SHELDRAKE (AGS-19) between 22 October and 25 November 1962. The purpose of this survey was to obtain geomagnetic and bathymetric data in an offshore area not previously subjected to systematic surveys. This work was performed as part of U. S. Naval Oceanographic Office joint projects M-15 and H-50. Location of the survey area is shown in figure 1.

The primary purpose of this report is to present the geomagnetics phase of the survey. Bathymetric data are included for correlation with the geomagnetic data and to aid in geologic interpretation.

II. SURVEY OPERATIONS

A. Conduct of Survey

This survey was conducted in an 18,000 - square-mile area located northeast of the southern Bahama Islands (figure 1, Index Chart). Primary survey lines were run in a northeast-southwest direction perpendicular to the trend of the southern Bahamas. Average track spacing was 5 miles. Five cross-check lines were run to check navigational control and to define more clearly certain bathymetric features (figure 2, Track Chart). The ship's average speed while surveying was 12.5 knots. Magnetic and bathymetric data were collected simultaneously along all survey lines.

In the survey area, the ship's position was fixed at 15 minute time intervals using Loran-A. Fix accuracy, as determined by cross-check lines, was within one mile. The most accurate fixes were in the west-central part of the survey area, and the least accurate occurred in the eastern part. Loran-A fixes at 30-minute time intervals were used to plot the tracks to and from the survey area.

B. Instrumentation

Total magnetic intensity measurements were made with a Varian nuclear resonance magnetometer, model V-4914. To diminish the effect of the ship's magnetic field, the sensor unit was towed approximately 700 feet astern of the ship. Because of equipment design, magnetic data were recorded as "magnetometer counts," a unit of measurement inversely related to the magnetic field intensity. These units were recorded in analog form on a Sanborn Galvanometric Recorder.

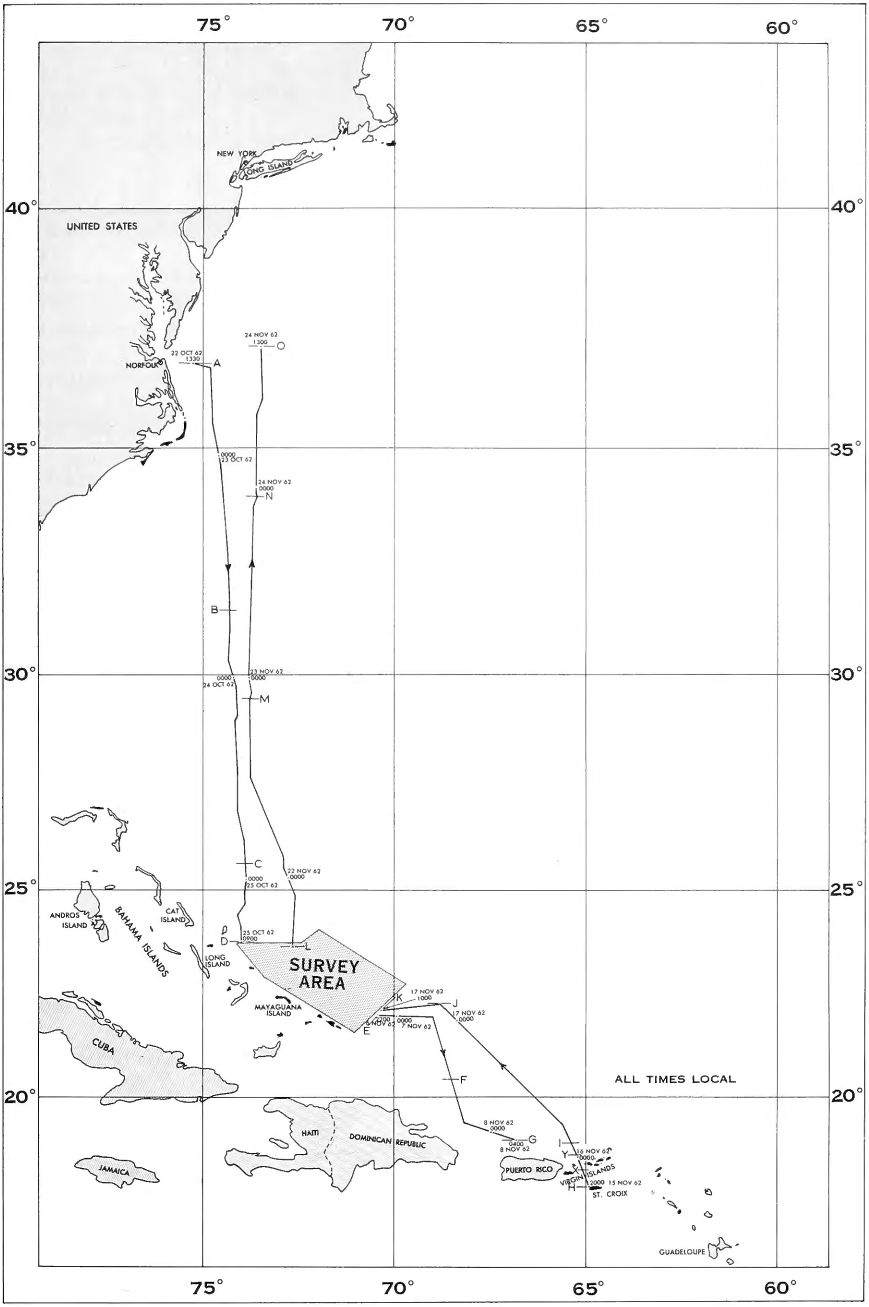

FIGURE 1.—INDEX CHART

Bathymetric data were obtained with a Precision Depth Recorder (MK XI) and an AN/UQN 1-C sonar sounding set using an unstabilized transducer.

III. DATA PROCESSING

All magnetic data were scaled for absolute values of total intensity in gammas using a specially constructed conversion template. These values for the survey area then were plotted on a 1:500,000-scale track chart. Using this chart, a total magnetic intensity contour chart (figure 3) was constructed with a contour interval of 50 gammas.

A regional magnetic intensity contour chart for the southern Bahama Area is shown in figure 4. Regional magnetic intensity contours were obtained by graphically smoothing the total intensity contours.

To amplify the trends and character of the magnetic anomalies, a residual magnetic intensity contour chart was constructed (figure 5). This residual chart was prepared by removing the regional magnetic intensity values from the observed total intensity values.

Magnetic data were not corrected for temporal variations of the earth's magnetic field. The cross-check lines run in the survey area indicate that temporal variations were less than the contour interval chosen. San Juan Magnetic Observatory records show that no major magnetic disturbances occurred during the entire survey period.

A bathymetric contour chart (figure 6) was constructed at the same scale as the above charts and has a contour interval of 20 fathoms. No sound velocity or other corrections have been made to the bathymetric data.

IV. SURVEY RESULTS AND DESCRIPTION OF FEATURES

A. South Bahama Area Survey

As a result of this survey, the geomagnetic field and bathymetry of an 18,000-square mile oceanic area near the southern Bahama Islands have been charted in detail. Magnetic total intensity contours and residual magnetic intensity contours are shown in figures 3 and 5 respectively. Bathymetric contours are shown in figure 6. The simultaneous collection of magnetic and bathymetric data allows direct correlation between the magnetic and bathymetric charts of this area.

The residual magnetic contour chart (figure 5) shows three significant magnetic lineations in the survey area. The most pronounced of these magnetic trends is located in the southern part of the area where the anomalies strike N74°W. This direction parallels structural trends in Jamaica, central Cuba, and in the northern part of Hispaniola. These structural trends are believed to have been established in the Jurassic and late Cretaceous periods (Schuchert 1935, pp. 413; 483). The anomalous trend does not have any definite association with bathymetric features in the survey area. Using empirical slope techniques, depth estimates indicate that the top of the magnetic source of the anomaly lies at a depth of 11 nautical miles below sea level.

On the northwestern side of the survey area is a second magnetic trend. This trend, striking N50°W, is parallel to both the strike of the southern Bahama Islands and the bottom features on the northwest and southeast sides of the area (figure 6).

The third magnetic trend, evident in the northeastern section of the area, strikes N31°E. This trend is a very pronounced series of

parallel positive and negative anomalies. The bathymetric contour chart (figure 6) shows a series of small bathymetric features paralleling the strike of these anomalies. This bathymetric lineation extends from Caicos Passage to a point approximately 80 nautical miles to the northeast. A computer program for polynomial fitting of surfaces by least squares will be used to determine whether the magnetic trend extends to the southeast into Caicos Passage. Estimates indicate that the top of the source of these magnetic anomalies is between 3 and 4 nautical miles below sea level.

The linearity, extent, and direction of these three magnetic anomalies suggest that this area is the focus of three major faults or fault zones. At least one, in the southern part of the area, appears to occur in the basement.

An interesting magnetic anomaly is found in the extreme eastern corner of the survey area. This anomaly (shown in figure 3) has steep gradients and high amplitudes, but no bathymetric feature is associated with the anomaly. Depth estimates using empirical methods indicate a depth of approximately 5 nautical miles to the top of the source of the anomaly. This depth is about 2 miles below the present ocean floor.

B. Enroute Survey

An additional 2350 nautical miles of geomagnetic and bathymetric data were collected concurrently while proceeding along tracks to and from the survey area. This information is presented in profile form in figures 7 through 16. Profile locations are shown in figure 1.

Profile A-B (figure 7) shows the characteristic continental slope anomaly found off the east coast of the United States (U. S. Naval Oceanographic Office Technical Report 133, pp. 11 through 23). Profiles B-C and C-D (figures 8 and 9) show no distinctive features other than the normal geomagnetic gradient.

Profiles F-G and I-J (figures 10 and 13) were made while crossing over the Puerto Rico Trench. Profile F-G is relatively smooth over the trench, but profile I-J shows what appears to be a small, positive anomaly in the trench area.

Profile H-I (figure 11) extends from the island of Saint Croix across the Virgin Islands platform. This profile shows very high amplitude magnetic anomalies on both sides of the platform. The anomaly on the southern side is attributed to a fault of late Cenozoic origin described by Schuchert (1935, p. 474). The anomaly on the northern side is believed to be related to a fault described by Butterlin (1956, p. 373). There are many short-wave-length anomalies with steep gradients on the platform itself (figure 12, profile X-Y). These are attributed to the presence of basic igneous material a short distance below the present ocean floor.

Profile J-K (figure 10) shows a broad magnetic anomaly located just east of the survey area. There is no evident bathymetric feature associated with this anomaly.

Except for several small magnetic anomalies associated with small bathymetric features in the southernmost part, profiles L-M, M-N, and N-O (figures 14, 15, and 16) show no distinctive anomalies.

V. SUMMARY OF FINDINGS

Three diverse geomagnetic trends are exhibited in this detailed geomagnetic survey off the southern Bahama Islands. One of these extensive lineations, striking N74^{o}W, agrees with some of the structural trends of the Antilles. Perhaps because of the depth of burial of its source, the anomaly shows no definite correlation with the bathymetry in the survey area.

The N50^{o}W strike of a second magnetic trend is reflected in the lineations of bathymetric features in the survey area, and also by the trend of the southern Bahamas Islands.

The third trend is formed by a series of parallel, linear magnetic features striking N31^{o}E. This trend is paralleled by a linear arrangement of bathymetric features in the center of the survey area.

These three magnetic lineations may indicate that this area is the focus of three major fault zones.

FIGURE 2.—SOUTH BAHAMA AREA TRACK CHART

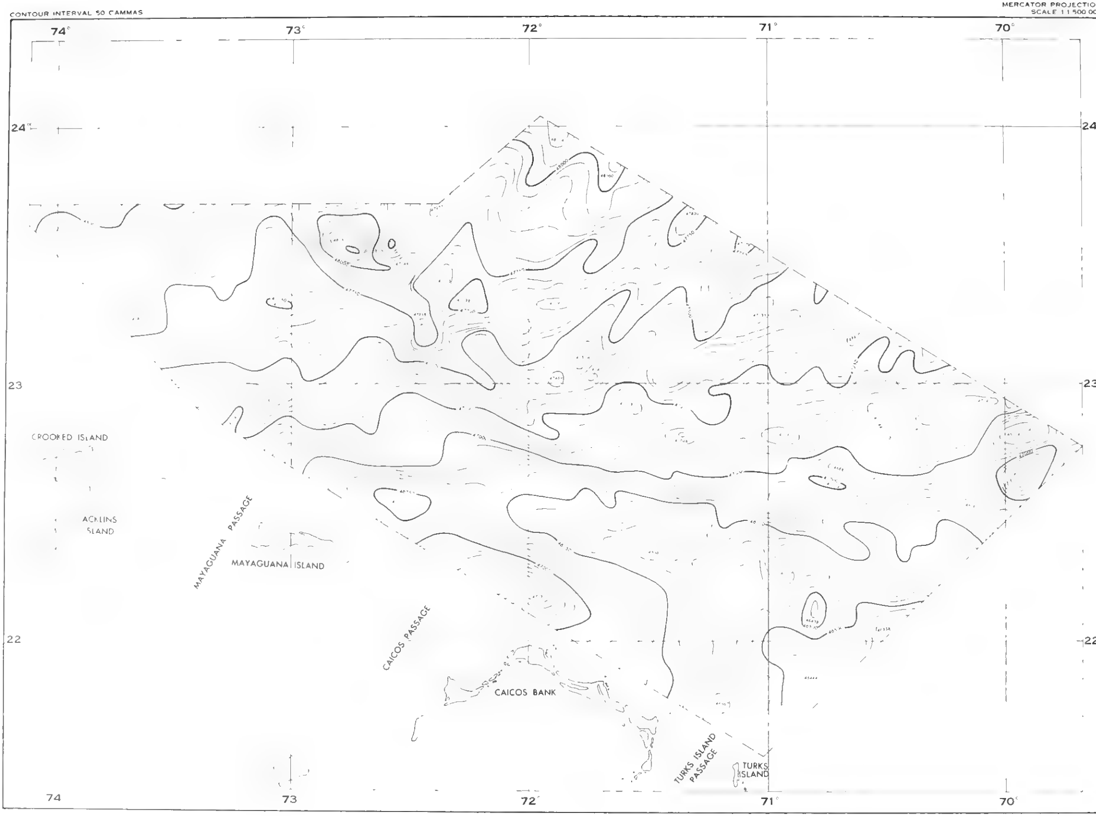

FIGURE 3.—SOUTH BAHAMA AREA MAGNETIC TOTAL INTENSITY CONTOUR CHART

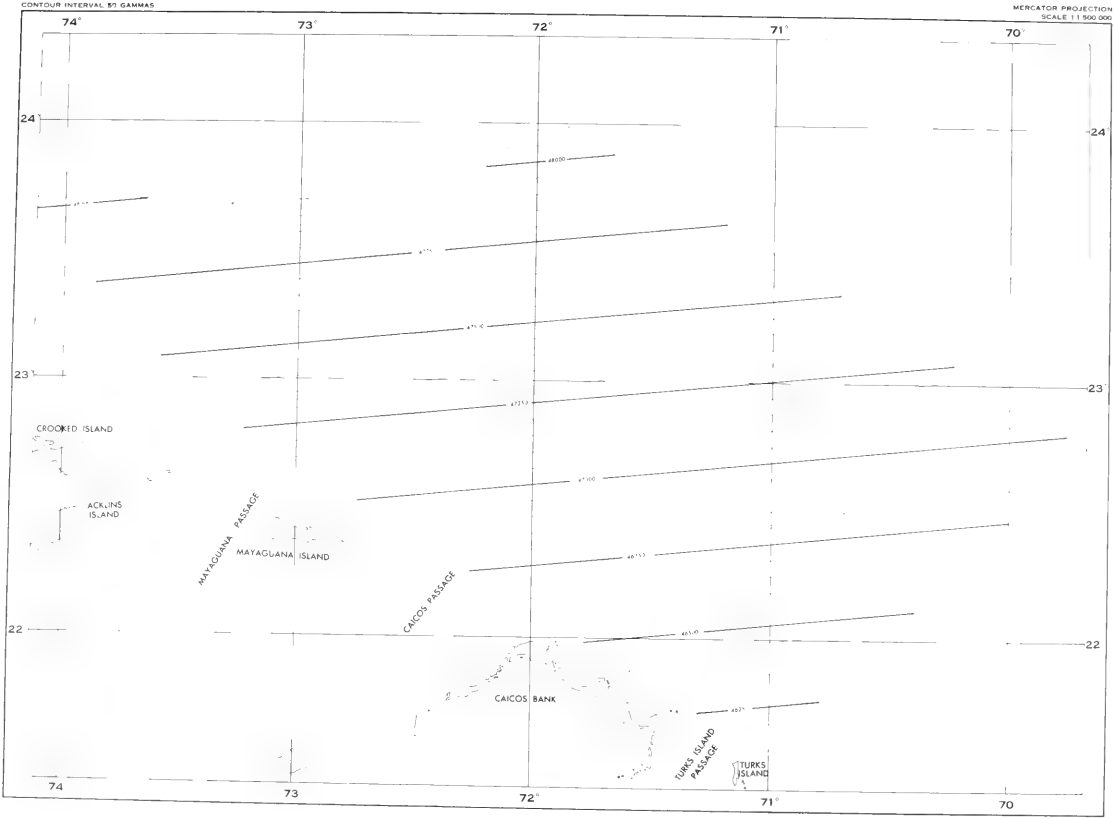

FIGURE 4.—SOUTH BAHAMA AREA REGIONAL MAGNETIC INTENSITY CONTOUR CHART

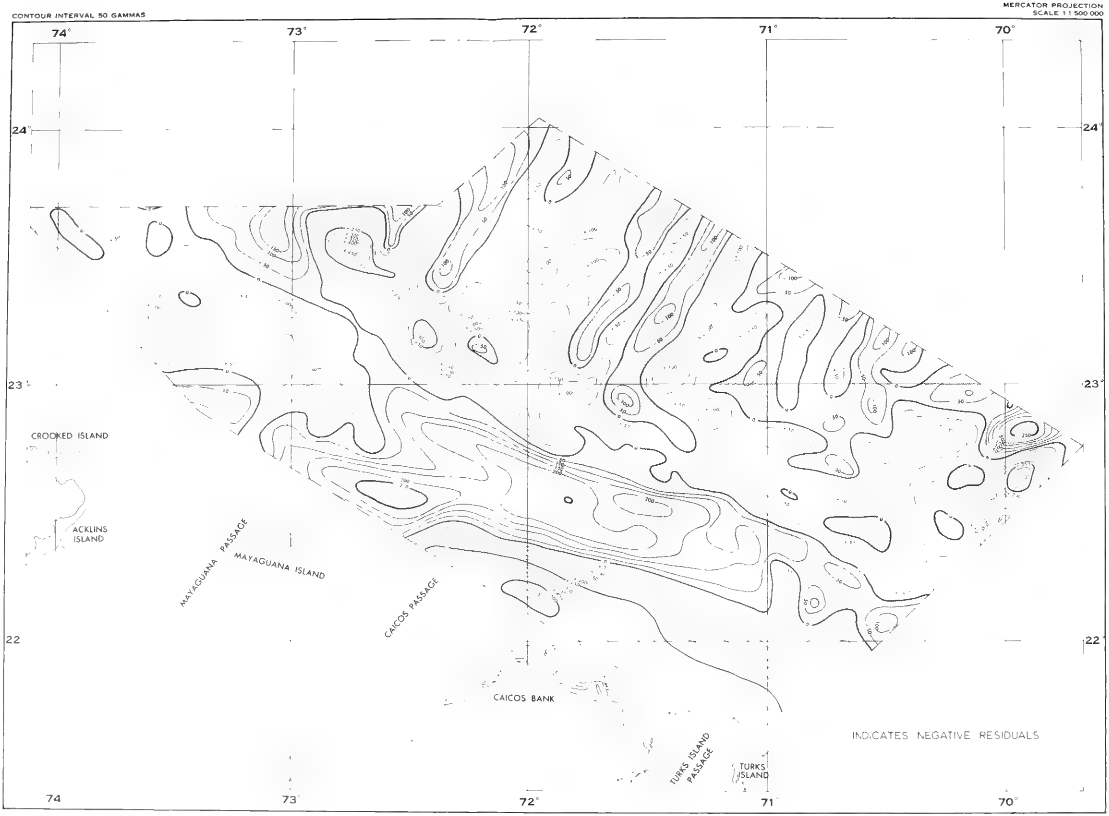

FIGURE 5.—SOUTH BAHAMA AREA RESIDUAL MAGNETIC INTENSITY CONTOUR CHART

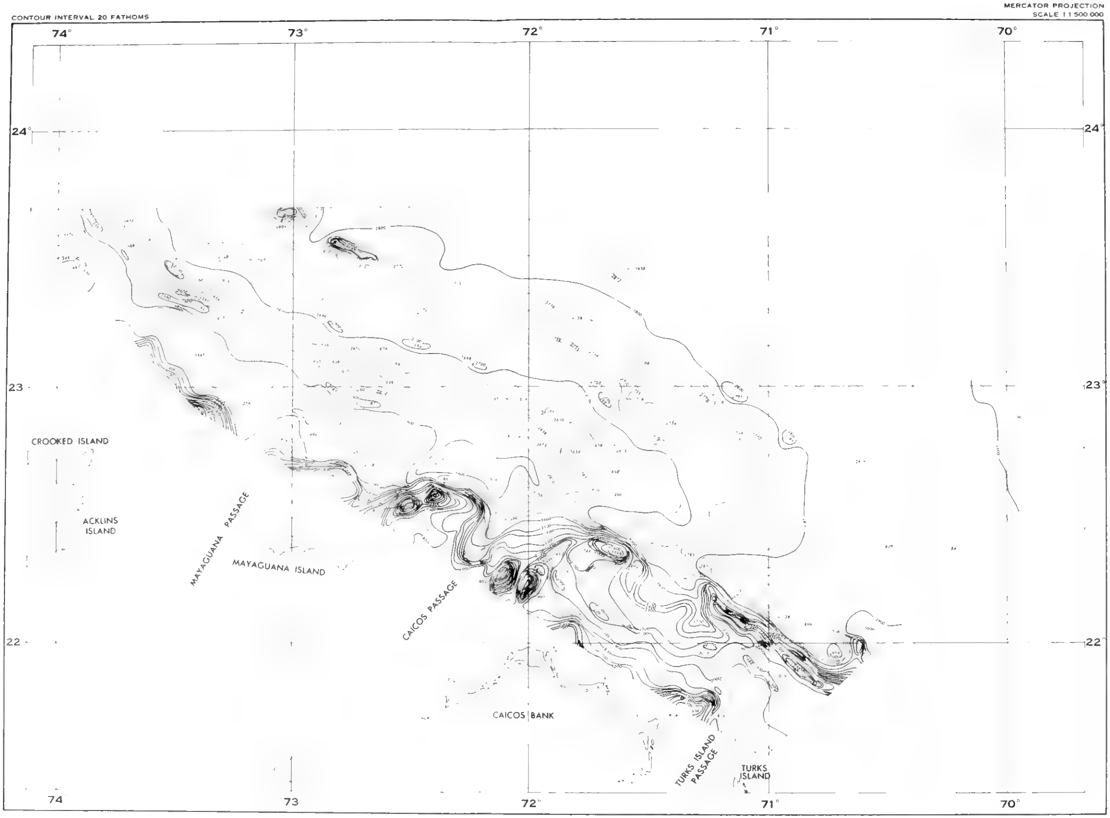

FIGURE 6.—SOUTH BAHAMA AREA BATHYMETRIC CONTOUR CHART

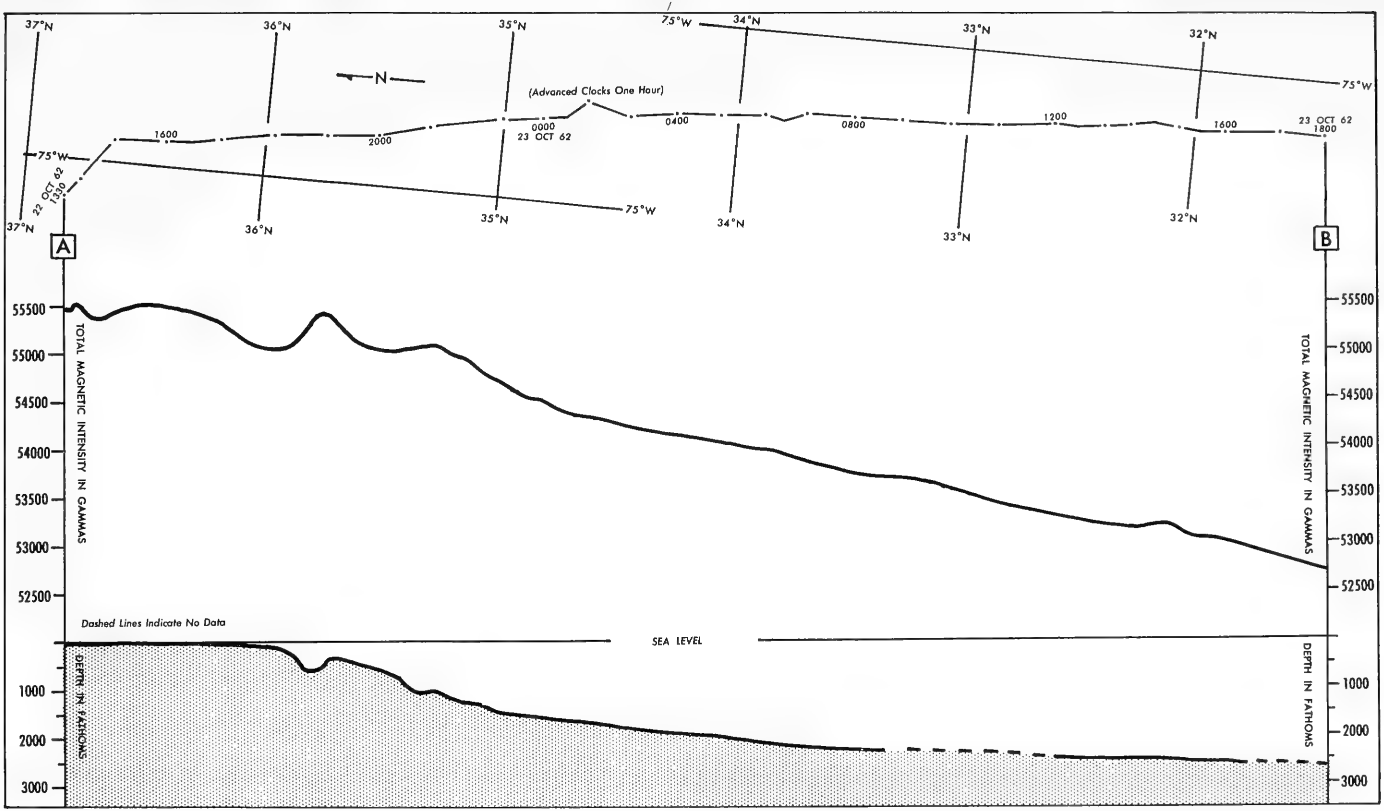

FIGURE 7. — MAGNETIC AND BATHYMETRIC PROFILES A-B

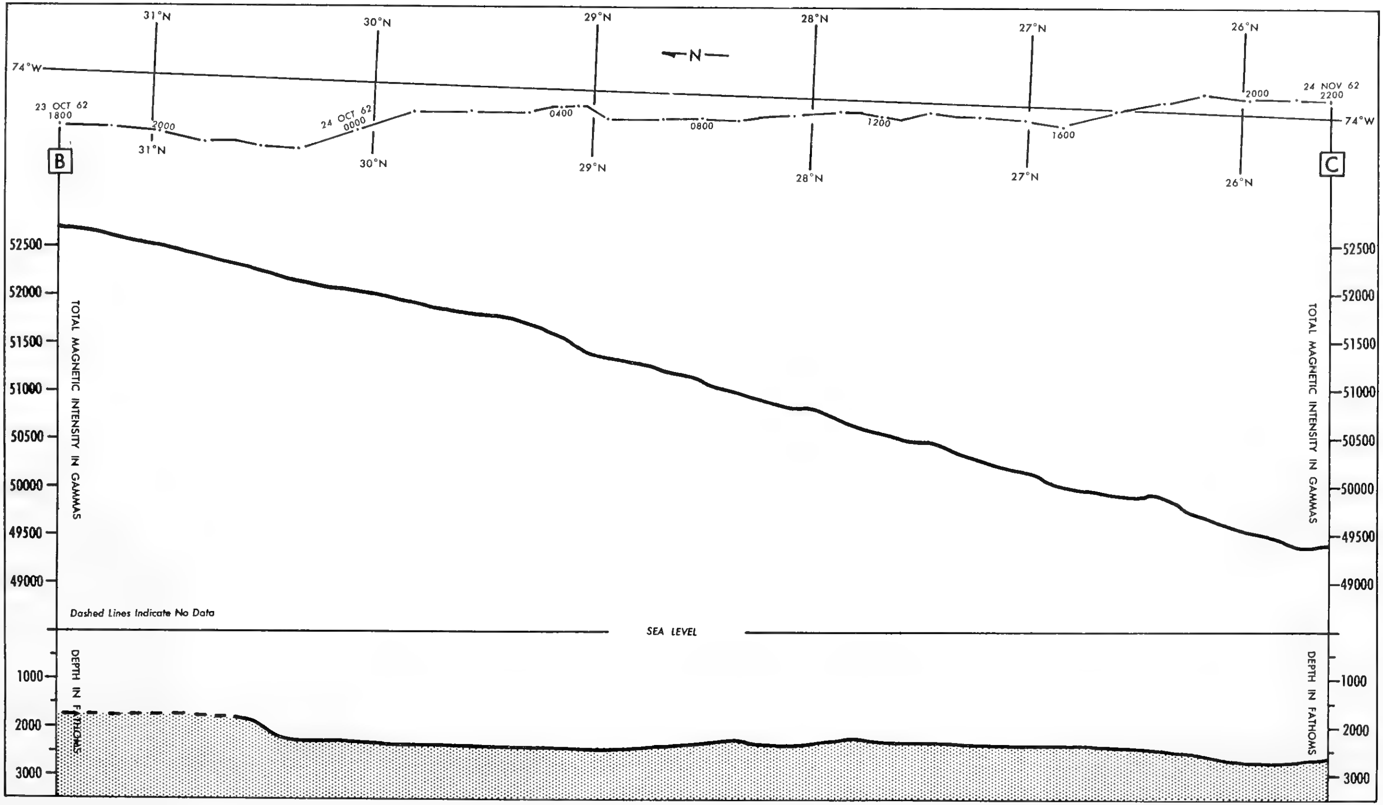

FIGURE 8. — MAGNETIC AND BATHYMETRIC PROFILES B-C

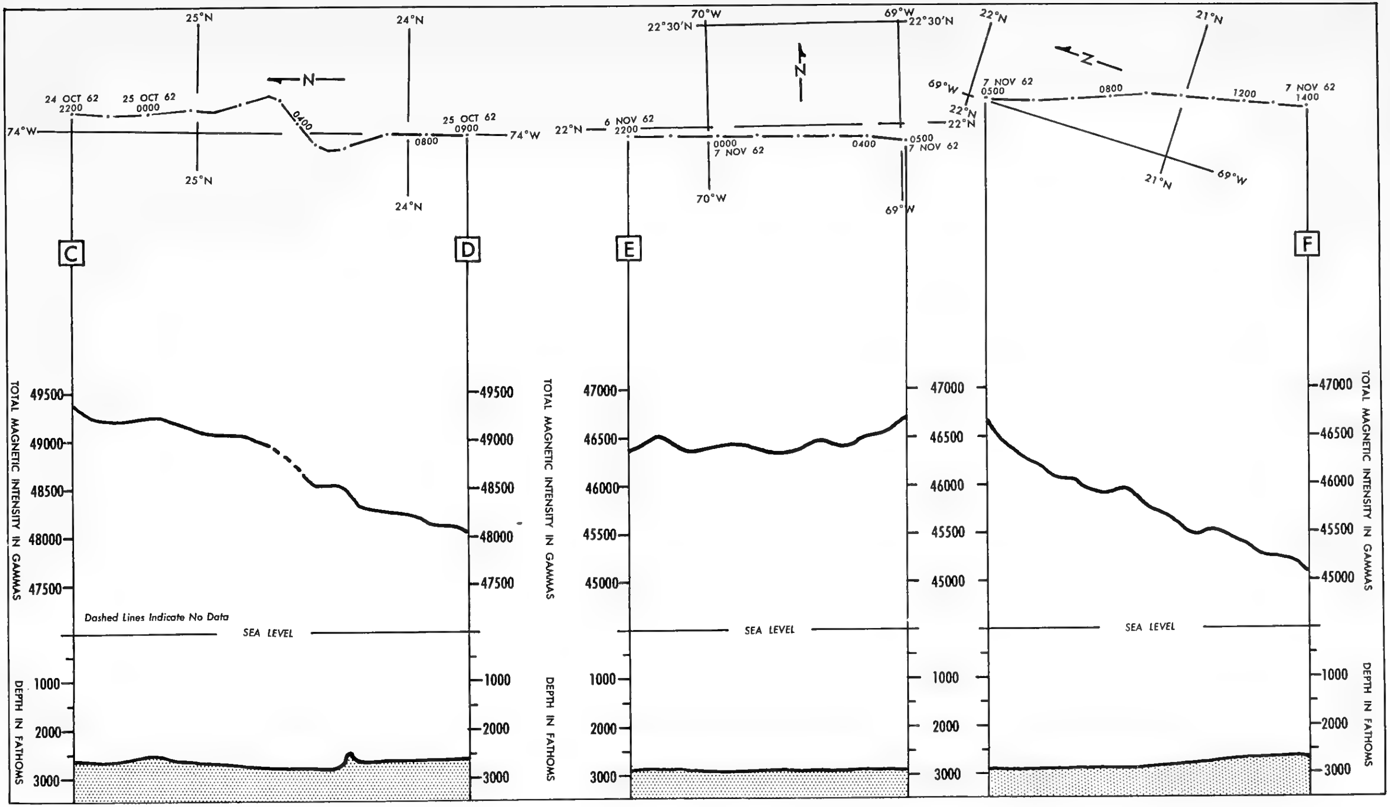

FIGURE 9. — MAGNETIC AND BATHYMETRIC PROFILES C-D AND E-F

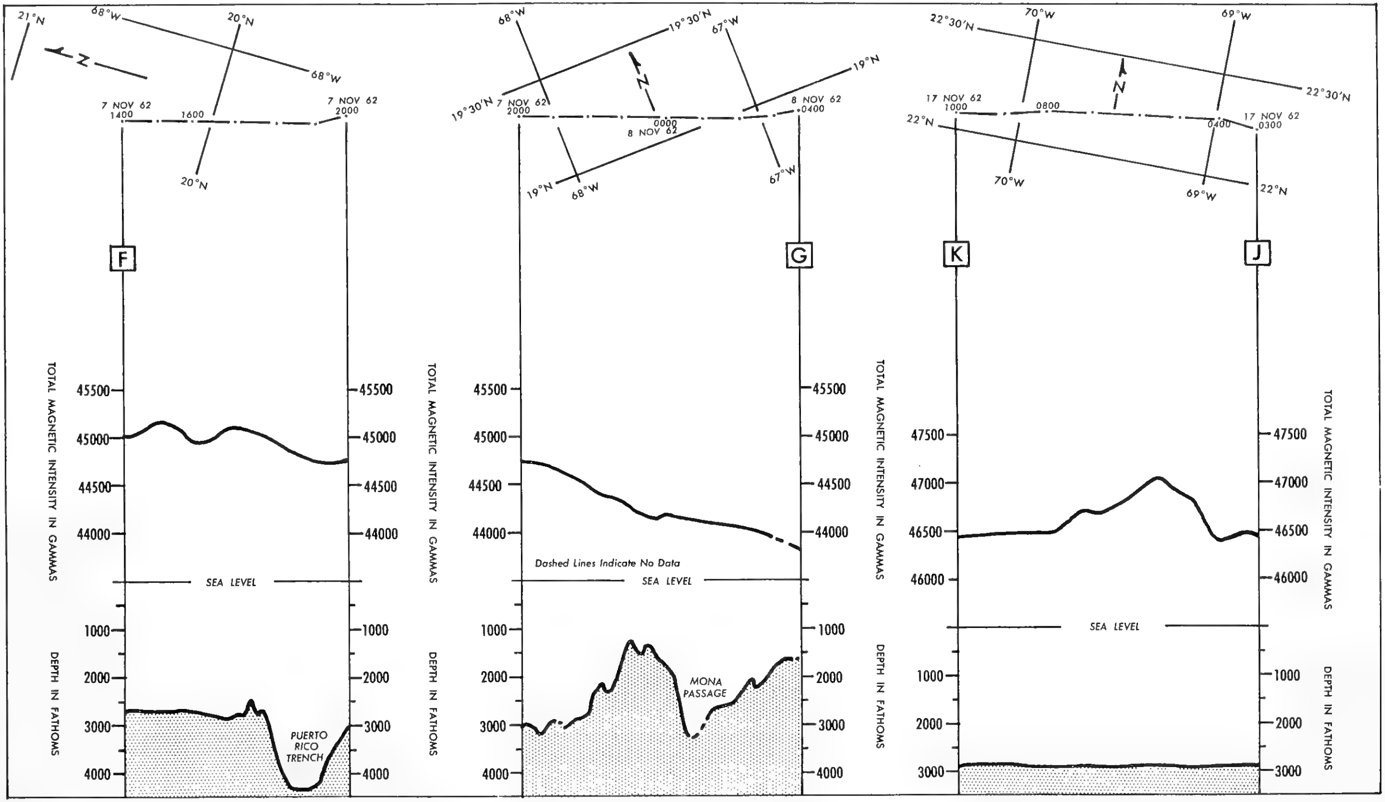

FIGURE 10. — MAGNETIC AND BATHYMETRIC PROFILES F-G AND J-K

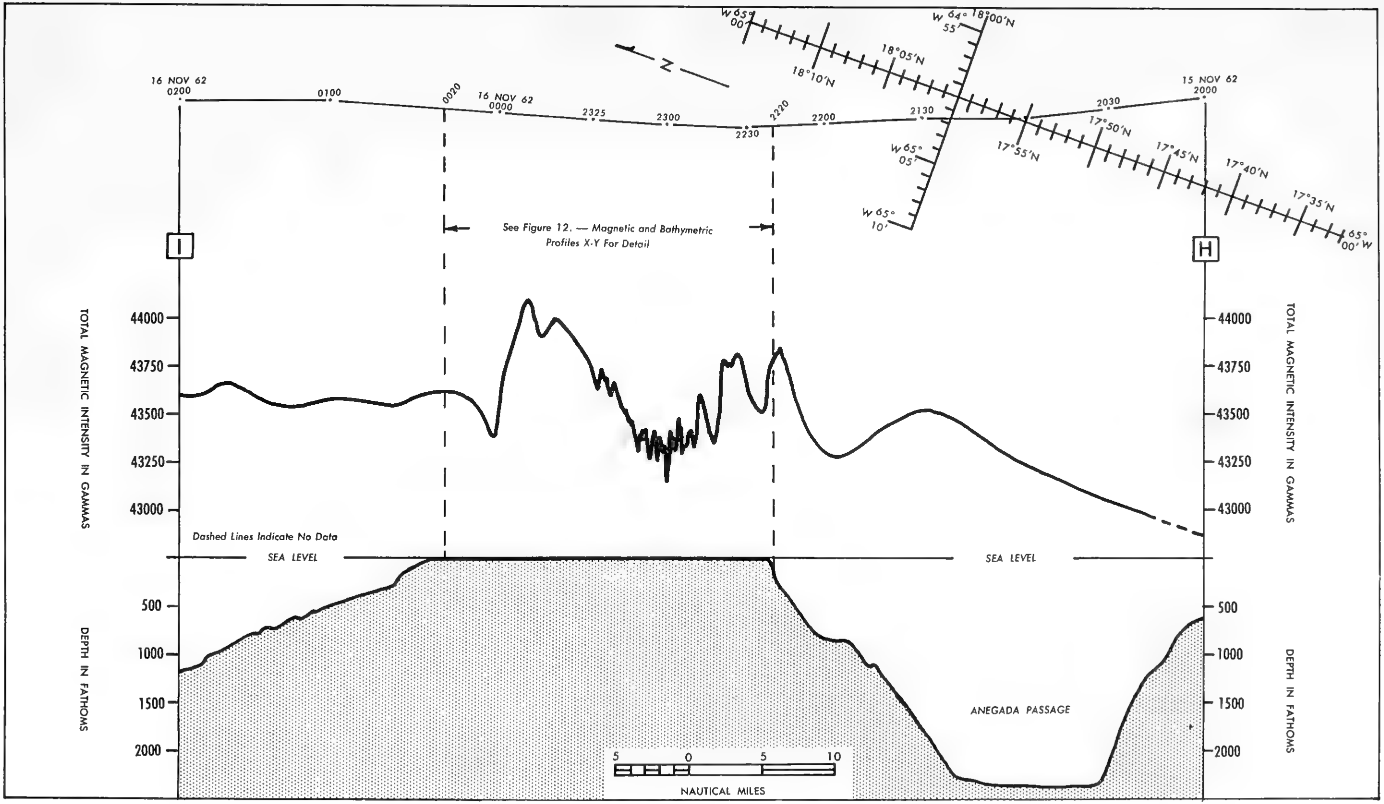

FIGURE 11. — MAGNETIC AND BATHYMETRIC PROFILES H-I

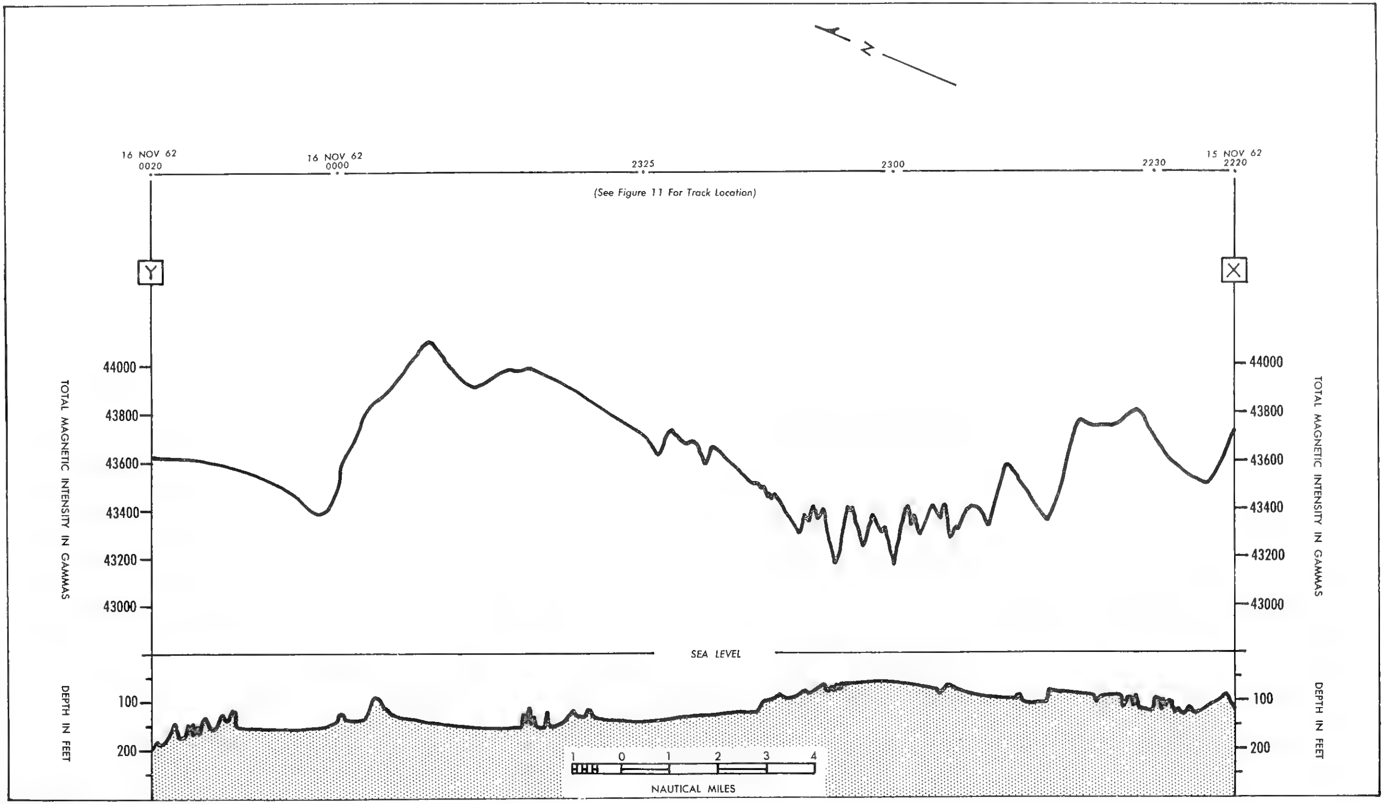

FIGURE 12. — MAGNETIC AND BATHYMETRIC PROFILES X-Y

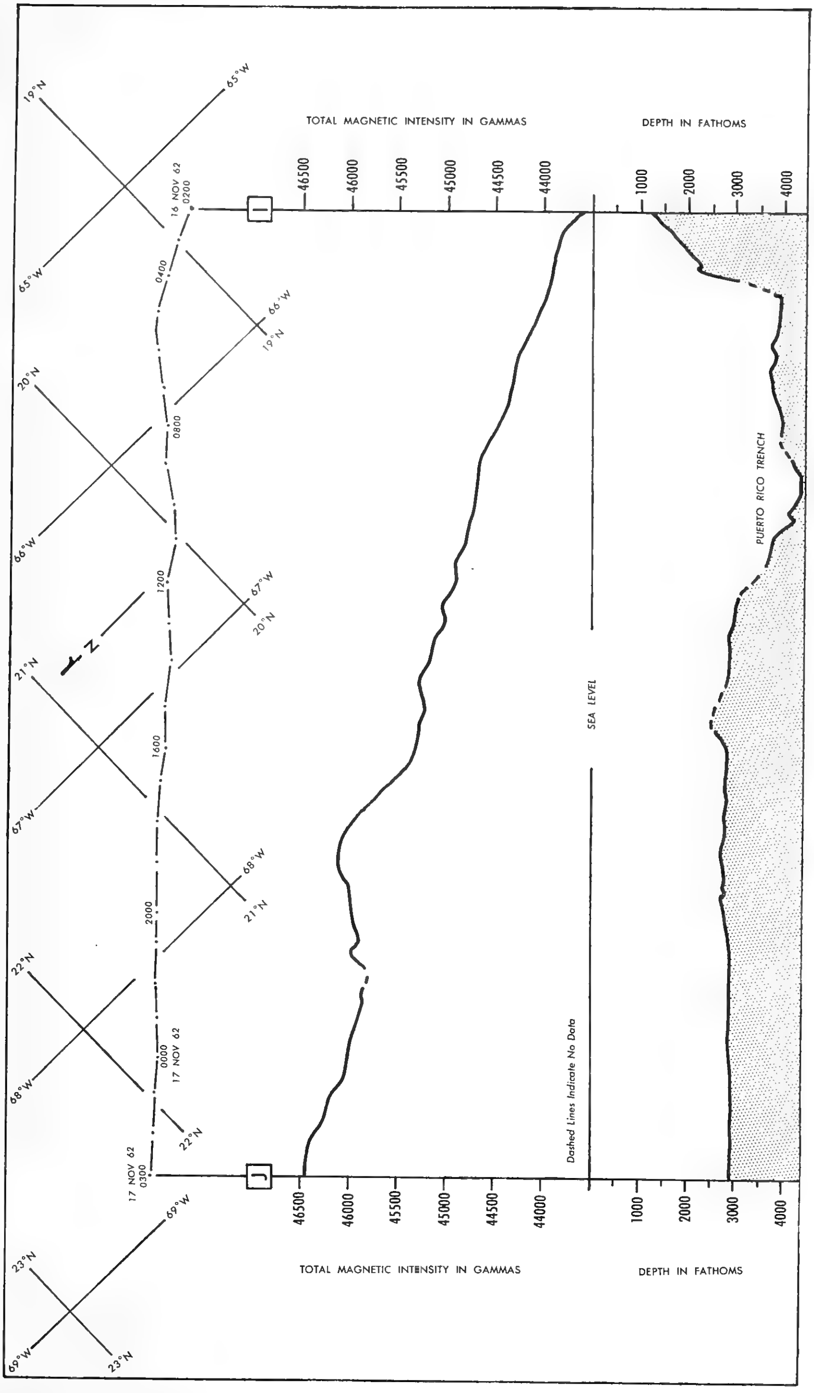

FIGURE 13. — MAGNETIC AND BATHYMETRIC PROFILES I-J

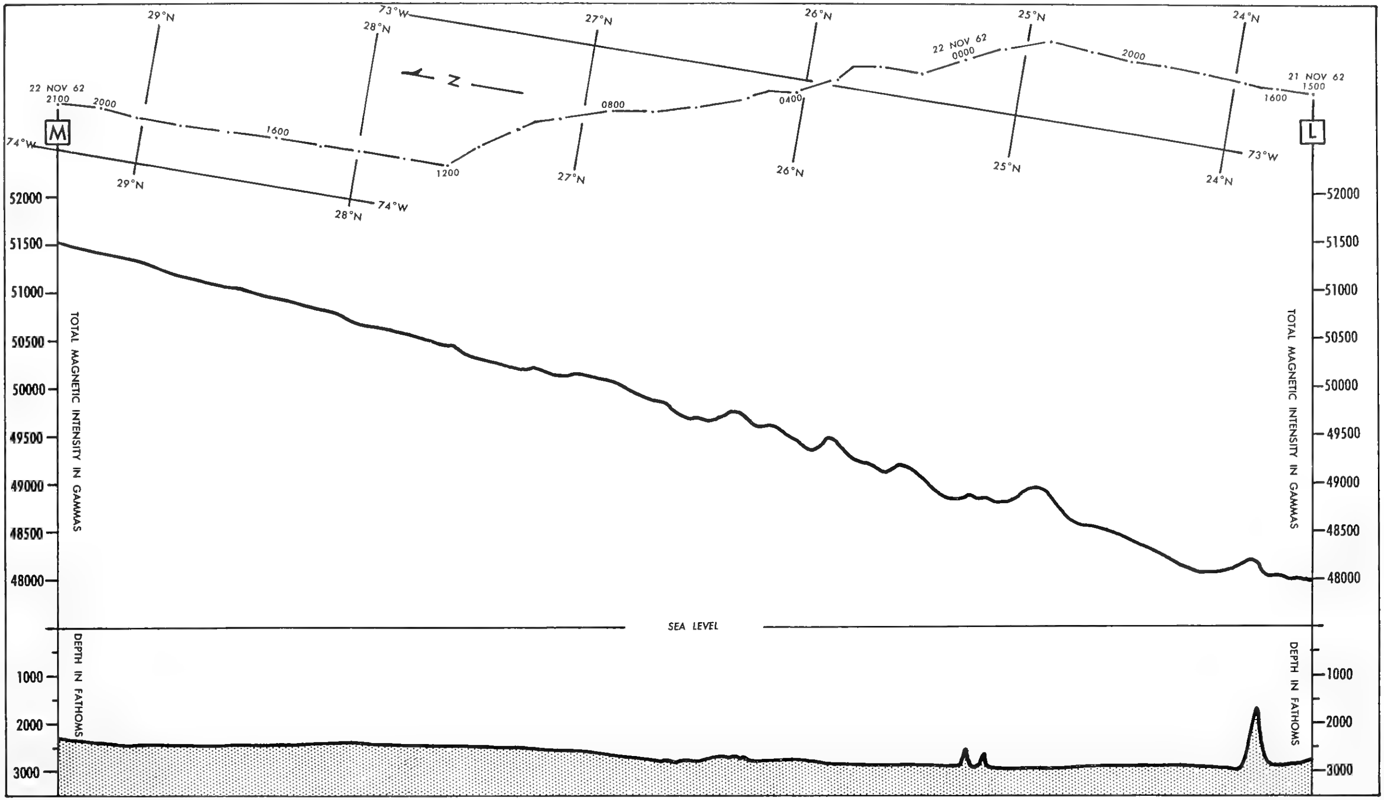

FIGURE 14. — MAGNETIC AND BATHYMETRIC PROFILES L-M

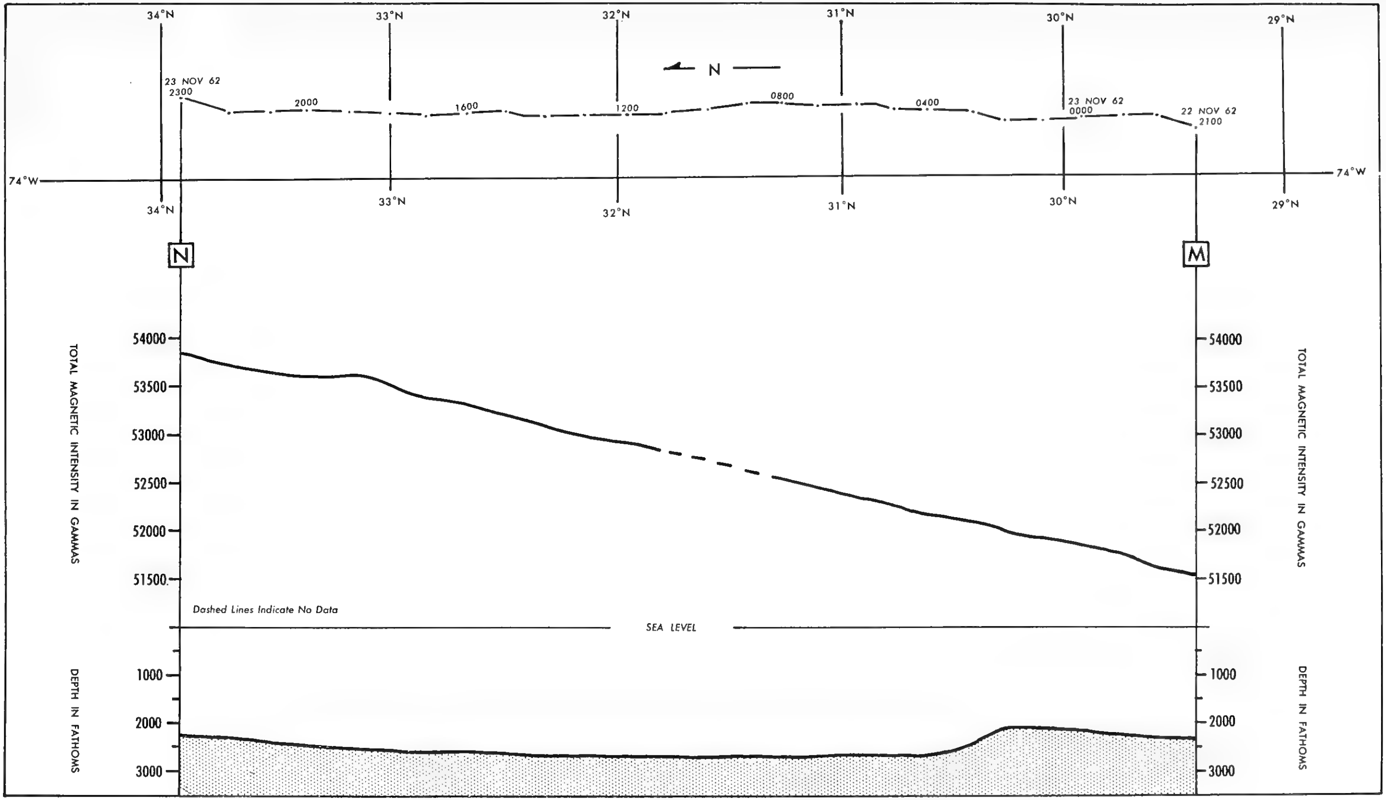

FIGURE 15. — MAGNETIC AND BATHYMETRIC PROFILES M-N

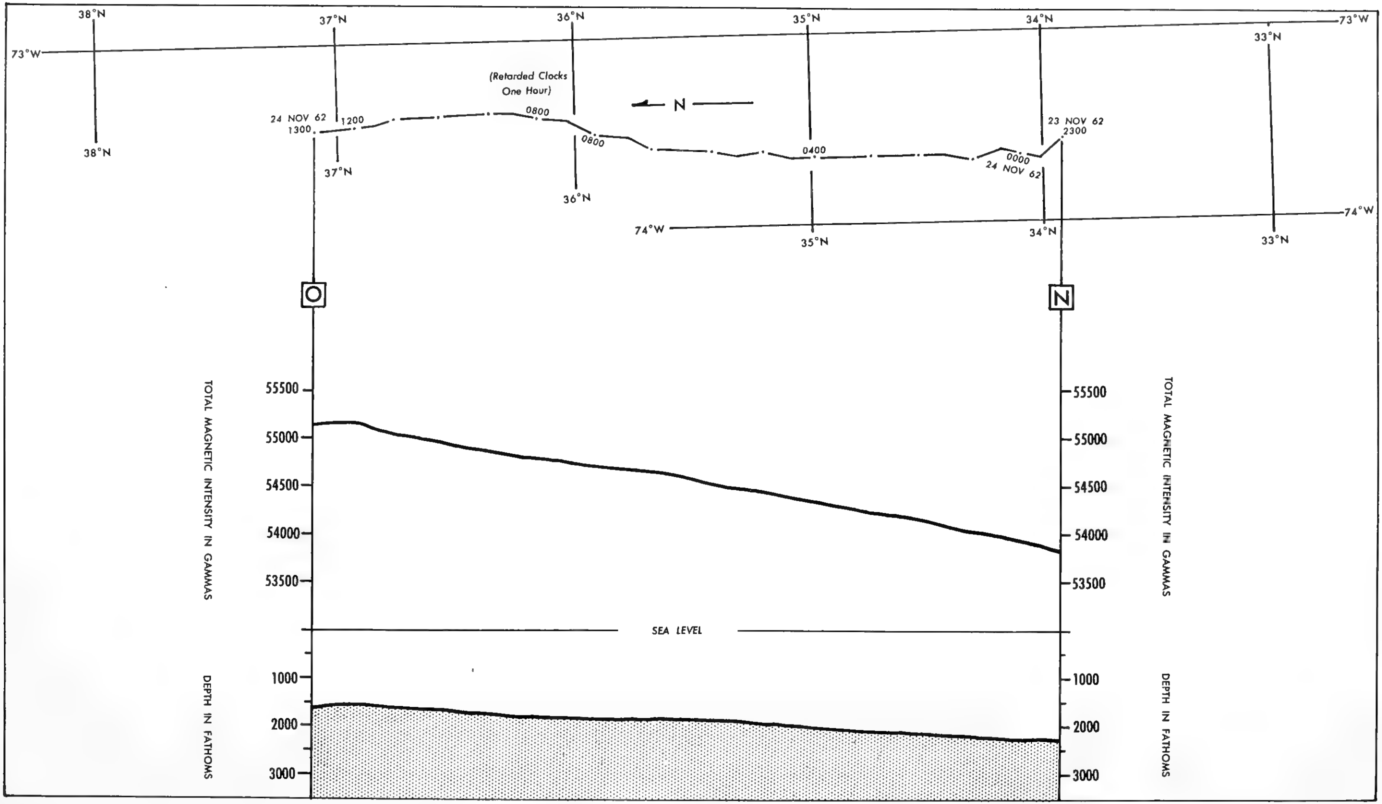

FIGURE 16. — MAGNETIC AND BATHYMETRIC PROFILES N-O

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